Assessing Southern Strait of Georgia Marine Bird Population Changes Since 1980: What We Know and What We Need to Know

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Abstract
The most comprehensive marine bird census of southern Strait of Georgia and surrounding waters was the Marine Ecosystems Analysis Puget Sound Project (MESA) conducted during 1978-79.

Since that time, census work has been limited to Christmas Bird Counts, twice-a-year airline flights during the 1990's, censuses of breeding islands, and work focused on marbled murrelets. While these studies have suggested dramatic population changes for some species, their geographic, methodological, and/or temporal limitations have prevented more comprehensive conclusions from being drawn. Here I assess our current state of knowledge about inshore marine bird populations. I also report the methods and preliminary findings of a new study designed to replicate important features of the 1970's MESA study with the goal of strengthening our knowledge about recent changes in local marine bird populations.

Introduction
Concern about the impact of human population growth and the resulting resource use, pollution, and habitat destruction on marine bird populations has played an important role in biological conservation for over 100 years. In the early 1900s, outrage over the use of marine birds feathers to decorate fashionable hats inspired some of North America's first conservation laws (Kastner 1986). In the 1960s, reactions to the collapse of the bald eagle population due to the effects of DDT resulted in the Endangered Species Act (Kastner 1986) and landmark shifts in American environmental ethics. Today, marine birds continue to be an important part of conservation work worldwide. Birds that utilize marine resources have been used as indicator species for monitoring the health of both marine feeding and terrestrial breeding ecosystems (Monaghan 1995) and for studying about how environmental degradation affects wildlife populations directly through habitat destruction (Ralph 1995), fishing bycatch (Melvin and Parrish 2001), oil spills (Wiens et al 1996), other pollutants (Elliot et al 1997), introduced species (Gaston 1994), and climate change (Smith et al 1999). Studying the impacts of marine bird populations on marine ecosystems has also proven important, as evidenced by recent problems with predation by Caspian terns (Collis et al 2002) and double-crested cormorants (U.S. Fish and Wildlife Service 2001). The fact that many marine birds have shown serious population declines, including many species listed as vulnerable, threatened, or endangered only underscores the importance of marine bird population research (Ralph 1995). Finally, the lay public's fascination with marine birds makes them a good subject for environmental education and public outreach about environmental issues.

Given these considerations, it is surprising to note that the only comprehensive marine bird census of northwestern Washington, Strait of Georgia and associated waters was the Marine Ecosystems Analysis Puget Sound Project (MESA) conducted during 1978-79 (Wahl et al 1981). The study censused 13 regions bordered by the waters off the mouth of the Strait of Juan de Fuca to the west, the Washington mainland to the east, the Canadian Gulf Islands to the north, and Port Townsend to the south (Wahl et al 1981). Within each region MESA researchers utilized a variety of techniques including population counts from over 100 shore-based sites, transect counts from ferries and small boats, breeding island counts, and aerial surveys. The study focused on a large variety of habitats, including bays and harbors, open shorelines, small islands and rocks, and open water. The researchers performed over 7,000 population counts, distributed fairly uniformly over the two-year period.

Since the MESA study, more restricted work has been done, including Christmas bird counts, once a year U.S. Fish and Wildlife censuses of breeding islands, and work focusing specifically on marbled murrelets. The most comprehensive marine bird population work in inshore waters has been the twice a year aerial population surveys conducted since 1992 as part of the Puget Sound Ambient Monitoring Program (PSAMP). In this study, continuous aerial transects were flown using a Dehaviland Beaver floatplane at a speed of 80-90 knots, and at an altitude of about 65 meters above the water (Nysewander et al 2001).

The PSAMP study is particularly important in that it was designed to allow comparison of its data with 54 aerial routes conducted during the MESA project to evaluate the long-term population changes of local marine birds. In this analysis, 414 PSAMP transects flown between 1992 and 1999 are compared to 124 MESA transects (thus, unique aerial routes were sampled an average of 7.7 times in the PSAMP study and 2.3 times in the MESA study). Results of this analysis suggested that substantial declines have occurred in a number of species (Table 1; Nysewander et al 2001), including representatives from all northwestern Washington marine bird families. For some species, such as western grebe, reported declines are as high as 95%. In addition, declines are seen in 16 of the 20 species or groups of species reported on by Nysewander et al (2001). Reports of such large declines have sparked concern for many of the species that breed or overwinter in northwestern Washington. However, to my knowledge, there has been little critical evaluation of the results of this study. There is a need, therefore, to evaluate the results of the PSAMP/MESA results by comparing them with the few other existing data sets for northwestern Washington marine birds. Here I compare the PSAMP/MESA results with the results from other relevant marine bird studies. My hope is that this comparison will refine our knowledge of how local marine bird populations have changed over the last 25 years. In addition, I describe a new study designed to more comprehensively compare current marine bird abundance with those found in the MESA study.

Table 1. Comparison of mean densities (birds/km2) for selected wintering species derived from comparable 1978-79 MESA and 1992-2000 PSAMP aerial track-lines (adapted from Nysewander et al 2001).

Species	MESA Density (95% C.L.)	PSAMP Density (95% C.L.)	% Change
Common Loon	2.28 ± 0.41	0.82 ± 0.22	-64.3
All Loons	7.99 ± 1.74	1.67 ± 0.94	-79.1
Red-Necked Grebe	4.31 ± 0.79	0.48 ± 0.43	-88.8
Horned Grebe	10.07 ± 1.50	1.77 ± 0.81	-82.4
Western Grebe	22.19 ± 4.01	1.07 ± 2.18	-95.2
Double-Crested Cormorant	4.97 ± 1.58	1.90 ± 0.86	-61.7
All Cormorants	17.61 ± 4.21	8.29 ± 2.29	-53.0
Great Blue Heron	0.61 ± 0.37	0.49 ± 0.20	-18.8
Black Brant	5.90 ± 3.10	1.99 ± 1.68	-66.3
All Scaup	27.34 ± 7.83	7.57 ± 4.25	-72.3
Harlequin Duck	4.33 ± 2.98	12.51 ± 1.62	+188.6
Long-Tailed Duck	13.79 ± 4.85	1.24 ± 2.63	-91.0
All Scoters	74.56 ± 17.78	32.04 ± 9.65	-57.0
All Goldeneyes	18.29 ± 5.70	14.15 ± 3.09	-22.6
Bufflehead	49.83 ± 23.63	59.85 ± 12.82	+20.1
All Mergansers	8.01 ± 4.13	12.45 ± 2.24	+55.3
Bald Eagle	0.42 ± 0.44	0.57 ± 0.24	+35.4
All Gulls	133.97 ± 77.35	75.71 ± 41.98	-43.5
Pigeon Guillemot	1.53 ± 0.59	0.69 ± 0.32	-55.2
Marbled Murrelet	4.67 ± 2.70	0.18 ± 1.47	-96.3

Comparison of Study Results

I compared results from three main data sets to provide an overview of winter northwestern Washington marine bird abundance, including the PSAMP/MESA comparison (Nysewander et al 2001), Christmas bird count data (CBC) averaged from seven coastal Washington State CBCs that ran continuously from the 1970s to the 1990s (Bellingham, Gray's Harbor, Kitsap County, Ledbetter Pt., San Juan Ferry, Seattle, and Tacoma; National Audubon Society 2003), and CBC data for Bellingham Bay (Wahl 2003). I show the Bellingham Bay data by itself because it avoids the pitfalls that often mark other CBC data in that all observations were made by one observer during the 30 years the count has been conducted. In addition, the methods have remained the same over that time (Wahl 2003).

Noticeable differences exist between the results of these studies of marine bird populations in northwestern Washington (Table 2). Of the three main data sets I compared (I will introduce and describe the WWU/MESA comparison later in this paper), the PSAMP/MESA data showed greater declines than either the Bellingham Bay or compiled CBC data for most of the species or species groups compared. The compiled Washington CBC

data or Bellingham Bay CBC data tended to show the least decline or greatest increases. For about half of the species analyzed, the PSAMP/MESA data showed considerably greater declines than the CBC data, especially for species such as common loon, horned grebe, western grebe, double-crested cormorant, scoters, and pigeon guillemot.

One important question, then, is to ask how accurate the different data sets are? They are not easy to compare for several reasons. First, most of the CBC data comes from outside the region used in the PSAMP/MESA comparison. Thus it is possible that declines in NW Washington have been greater than in Puget Sound or in Southwestern Washington. Furthermore, several factors may have led to overestimates in recent CBC data, including increased number of observers over time, increased amount of effort over time, and incorporation of boats in more recent surveys (Sauer and Link 2003; Terrance Wahl *personal communication*). These problems were avoided in the Bellingham CBC count, however, and the Bellingham CBC data shows less of a decrease or greater increases than the PSAMP/MESA data for almost all species compared. Of course the Bellingham CBC data is from one geographic region, and thus is difficult to compare directly to the PSAMP/MESA comparison. Finally, the method of comparing the PSAMP data to the MESA data, while important for showing probable declines for a number of species or species groups, may be limited in several ways. First, the aerial transects used for comparison with the MESA study were only conducted once a year during the winter, increasing the variability of the count, and limiting the study's ability to address seasonal changes or species that visit inshore waters at other times of the year. Second, conducting the counts from an airplane forced the researchers to concentrate their efforts on straight coastlines, excluding many bays that are important sites for marine birds. The aerial census work was only a minor part of the overall MESA study and may not be as useful for comparison as other aspects of the study, such as shore-based and boat-based work. Shore-based and boat-based census work did occur in the many bays and inlets along the coast of NW Washington inshore waters. Third, the difficulty of identifying birds during aerial flights often limited the resolution of the study to higher taxonomic groups, thus limiting its ability to provide specific information for some species (for example, loons, scoters, mergansers, and cormorants).

Potential effects of observer bias and differences between the aircraft used may also have biased the study towards underestimating marine bird abundance. For instance, the PSAMP surveys were flown in a louder aircraft than the aircraft used in the MESA study (Nysewander et al 2001), and may have caused more birds to dive before being detected. The PSAMP aircraft also offered a smaller transect width than the MESA aircraft (Nysewander et al 2001). While the PSAMP researchers compensated mathematically for their smaller transect width, it is still possible that their data is biased towards less detections since the area obscured by floats on their aircraft may be the area where birds may have most easily detected and more accurately identified. Thus, while the PSAMP/MESA comparison does clearly suggest that significant marine bird population declines have occurred in the last 25 years, it lacks the geographic, seasonal, and taxonomic resolution necessary to make strong conclusions about these changes. In fact, the one strong conclusion that one can make from assessing these studies is that more comprehensive population survey work needs to be done before we can make statements about recent changes in marine bird populations with confidence.

Table 2. Recent Percent Changes in Marine Bird Abundance for Selected Marine Birds Wintering In Northwestern Washington. Acronyms used in the table include: BBS (Breeding Bird Survey); CBC (Christmas Bird Count); MESA (Marine Ecosystems Analysis Puget Sound Project); PSAMP (Puget Sound Ambient Monitoring Program); USGS (U.S. Geological Service); USFWS (U.S. Fish and Wildlife Service); WWU (current study conducted at Western Washington University). WWU/MESA comparison is based on the Western Washington University initial data from spring, 2003, from four locations: Drayton Harbor (6 dates), Bellingham Bay (3 dates), Padilla Bay (4 dates), and the portions of the Anacortes, WA to Sidney, B.C. ferry (4 dates), as compared with spring data from the 1978-1979 MESA study from the same four locations: Drayton Harbor (8 dates), Bellingham Bay (3 dates), Padilla Bay (6 dates), and the Anacortes, WA to Sidney, B.C. ferry (6 dates). PSAMP/MESA comparison data was not available for red-throated loons, long-tailed duck, and common murres.

Species	PSAMP/ MESA	in 7 WA CBCs	Bellingham CBC	WWU/ MESA	Other Studies
Red-Throated Loon	NA	-53	-38	-96	-53 in Alaska (Groves et al 1998)
Common Loon	-64	+53	+43	-17	-7 1966-98 Western BBS region (USGS 2003)
All Loons	-79	+1	+11	-17	
Red-Necked Grebe	-88	11	-67	-80	+3 1966-98 Western BBS region (USGS 2003)
Horned Grebe	-82	23	-18	-81	-2 1966-98 Western BBS region (USGS 2003)
Western Grebe	-95	+1	-25	-91	
Double-Crested Cormorant	-61	478	534	+353	
All Cormorants	-53	462	295	+160	
Great Blue Heron	-19	+72	+109	+405	
Brant	-66	-25	+397	-95	Pacific population declines since 1961 (Sedinger et al 1994)
All Scaup	-72	-24	-9	-81	Possible Declines in AK (USFWS 2003)
All Scoters	-57	48	113	-6	Possible declines all species (USFWS 2003)
Bufflehead	+20	+22	-10	-48	Stable in AK (USFWS 1999)
Long-Tailed Duck	NA	+130	-6	-87	-5.5 in Western AK (USFWS 1999)
All Mergansers	+55	+41	+32	-40	
Harlequin Duck	+189	+86	+47	+12	Probably Stable in NW (Goudie et al 1994)
Common Murre	NA	-60	-38	-88	Decreases in CA (Carter et al 2001)
Pigeon Guillemot	-55	130	0	-28	
Marbled Murrelet	-96	-63	-92	-83	Widespread Declines (e.g. Piatt and Naslund 1995)
Bald Eagle	+35	+405	+483	+114	Increases in N.A. since 1960s.

A New Study

The evidence that population declines have occurred, combined with our limited ability to know the degree of these changes is troubling for at least four reasons. First, northwestern Washington is an important breeding and migratory site for many marine bird species. Second, the widely ranging habitat needs of these species means that they can serve as biological indicators for ecosystems as diverse and wide-spread as old growth forests, island environments, arctic tundra, open ocean from Mexico to Alaska, and local inland marine waters. Third, the rapid growth in the Pacific Northwest's human population and the resulting use of land and water resources has had serious impacts on marine ecosystems and has likely affected marine bird populations. These problems are likely to be exacerbated as rapid human population growth continues into the future. Close monitoring of marine bird populations will be helpful in assessing future environmental health. Finally, work that enhances the health of marine bird populations may have economic benefits because many tourists are attracted to the area by its marine wildlife. It is noteworthy that the Northwest Straits Commission identified marine bird populations as a significant gap in our knowledge about northwestern Washington's inshore marine ecosystem (Northwest Straits Commission 2000).

To address this situation, I have been funded by Washington Sea Grant to collect population data that will allow direct comparisons with data collected during the MESA project to increase our knowledge about northwestern Washington marine bird population trends over the last 25 years. To do this, I plan to follow the MESA protocol while conducting shore-based population counts at about half of the MESA project's shore-based sites. I plan to focus on shore-based sites along the Washington mainland and in the San Juan Islands. While I originally planned to census each site once a month, the enthusiastic response of students in my census work has allowed me to double the frequency of our counts. I have chosen to focus most of this study's attention on shore-based counts because these likely produced the most reliable data during the MESA project (Terence Wahl, personal communication) and because they are relatively inexpensive to conduct and should complement the PSAMP research. In addition, I plan to conduct twice monthly transect surveys from Washington State and British Columbia Ferries that closely replicate the frequency and methods of the MESA project's ferry work. The comprehensive nature of conducting over 2400 shore-based counts and nearly 100 transect counts from ferries should contribute much to assessments of marine bird population changes.

In addition to repeating these aspects of the MESA project, I plan to enhance this study by conducting counts from aboard the Island Mariner Cruise's Orcawatch boat, based in Bellingham, Washington. Although the boat's primary mission is to take whalewatchers to see orca whales, it runs repeated transects at standard speeds while sailing to and from the whales, and often provides opportunities to census breeding birds by circling islands. In addition, its location near Western Washington University makes it an ideal platform for training students in marine bird identification and census techniques. It also provides an opportunity to educate the public about marine bird ecology and inshore marine ecosystem environmental issues.

This research project involves the participation of multiple individuals. The primary approach I am taking will be to rely on graduate and undergraduate students and community volunteers to assist me with the census work. All participants will be trained and tested in census techniques and marine bird identification skills. Student interns help coordinate the fieldwork and help organize and analyze data. Other students participate while gaining college credit through undergraduate research and independent study programs or as work-study employees. Community volunteers will be people with substantial experience identifying marine birds in northwestern Washington.

Early results from the first spring of our study suggest changes in marine bird abundance that are within the range set by the PSAMP/MESA comparison and CBC data sets (Table 2, WWU/MESA column). While these results are preliminary, they already show some striking patterns of changes in marine bird abundance. We expect subsequent data to improve the resolution of these changes as data from more coastal regions are incorporated into our data set, and as student identification skills and field techniques continue to develop.

Another important component of this project will be outreach to the lay public. First, researchers aboard the Island Mariner whalewatch boat will be encouraged during non-census times to interact with the customers aboard the boat. Second, I will encourage media representatives to join us during our census work to publicize the work we are doing and relevant issues. Third, I will communicate our research findings at public presentations within and beyond the study area.

I believe this effort will make significant contributions to our knowledge of local marine bird populations, provide rigorous hands-on scientific instruction, and help raise the lay public's awareness and appreciation of marine birds and the inshore saltwater ecosystems.

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